Note: This guidance pertains solely to investigation and assessment of the vapor intrusion exposure pathway from volatile organic compounds in soil, soil gas, sub-slab soil gas, indoor air, and groundwater.

1. **Introduction/Background.** The updated RBTLs for chemicals of concern that are volatile organic compounds (VOCs) do not include target levels for the indoor inhalation of vapor emissions from subsurface soil exposure pathway. As a result, soil data may only be used qualitatively to evaluate the presence of VOCs, but may not be used to determine whether VOCs in soil pose an unacceptable risk via the vapor intrusion pathway (i.e., in risk assessment). Soil gas sampling, sub-slab soil gas sampling, and/or indoor air sampling must be used to evaluate vapor intrusion risks.

2. **Initial Site Investigation and Comparison of Maximum Concentrations of COC to the DTLs.** This guidance presents a new process for evaluating vapor intrusion risks from VOCs in soil (but not in groundwater) at the initial investigation and DTL comparison phase, as follows.

   2.1. If Phase I Environmental Site Assessment (ESA) information for a site conclusively demonstrates that VOCs are not chemicals of potential concern at the site, the initial site investigation need not include soil sampling for VOCs. Note, however, in most cases some degree of environmental sampling will be necessary to rule out VOCs as chemicals of potential concern.

   2.2. If Phase I ESA information indicates VOCs could be present at a site, the initial site investigation must include the collection of soil samples to be analyzed for relevant VOCs (as determined by a Phase I ESA and other site information), unless site conditions are such that moving directly to soil vapor sampling without first collecting soil samples can be relied upon to define the extent of VOC contamination and produce data sufficient for risk assessment purposes. When soil sampling is conducted, the samples must be collected in suspected source areas, if known.

   2.2.1. If VOCs are detected in one or more soil samples at concentrations above the method detection limit (MDL), or if the detection limit for relevant VOCs in soil samples is elevated above the MDL for any reason, further evaluation of the indoor inhalation of vapor emissions from soils exposure pathway must occur via the collection and analysis of soil gas samples, as discussed in Section X of this guidance.
2.2.2. If VOCs are not detected in soil samples at concentrations above the MDL, further evaluation of the indoor inhalation of vapor emissions from soil exposure pathway is not required, unless other site information indicates otherwise.

2.3. Initial soil gas samples must be collected to represent maximum concentrations of VOCs in soil gas at the site through the collection of soil gas samples where the concentrations of VOCs in soil are greatest (i.e., source areas). The maximum concentrations of VOCs detected in soil gas are then compared to the soil gas DTLs.

2.3.1. If the maximum concentration of a VOC exceeds its corresponding soil gas DTL, or if the sample analysis detection limits exceed the MDLs, the vapor intrusion from soil pathway must be further evaluated.

2.3.2. If the maximum concentrations of all VOCs in soil gas do not exceed the corresponding soil gas DTLs, further evaluation of the vapor intrusion from soil pathway is not required.

2.4. The validity of the decisions made in accordance with subsections 2.1 through 2.3.2 above are premised on adequate and thorough initial site characterization and a resulting high degree of confidence that the initial site investigations have identified maximum concentrations of VOCs in all affected media at a site, as determined by the department’s project manager for the site.

3. **Delineation of VOCs in Soil.** A reasonable degree of delineation of VOCs in soil is typically necessary to guide soil vapor and sub-slab soil vapor sampling efforts and to facilitate a comprehensive and accurate assessment of risk from vapor intrusion. If one or more VOCs are found in soil at a concentration above the MDL, or if the sample analysis detection limits exceed the MDL (and whether or not VOCs are detected above these detection limits) the extent of soil contamination may be defined via the collection and analysis of additional soil samples.

3.1. **Delineation Criteria for Vapor Intrusion from VOCs in Soil.** Delineation of soil contamination shall use the MDLs as the delineation criteria. If the detection limits for a soil sample analyzed for the presence of VOCs are elevated above the MDL for any reason, each such sample shall be considered to be within the area of soil contamination.

3.2. Evaluation of Vapor Intrusion Following Delineation of VOCs in Soil. After soil contamination is adequately delineated, conduct further vapor intrusion investigations within the area of defined soil contamination.

4. All soil gas samples shall be collected in accordance with [to be determined], except as modified herein.

Comment [CT2]: Rewrite section 3 to be less prescriptive and allow for situations where delineation in soil to MDLs is not warranted.

Comment [CC3]: Not sure delineating all the way to non-detect before conducting further vapor sampling and risk assessment always necessary. Entirely possible the vapor plume that poses a risk could be much smaller than this. Also depends on whether there is a building being assessed. For now consider this a placeholder. We may want to define criteria for decision making rather than be this prescriptive.

5.1. Existing Slab-On-Grade Building. If a slab-on-grade enclosed building is present on the site and within 100 feet horizontally of VOCs in soil or groundwater, the following sample progression will generally apply: near-source soil gas, soil gas (within 3 to 5’ vertically and 10’ horizontally of the building), sub-slab, crawl space (if applicable), indoor air. The rationale for the sampling approach used shall be presented and explained in a work plan submitted to the department for review and approval.

5.1.1. Near-source sampling is conservative because it represents worst case conditions. Therefore, if near-source samples do not exceed target levels, further sampling for VI should not be necessary.

5.1.2. Conducting sub-slab and indoor air sampling without first conducting near source and/or soil gas sampling may be appropriate in some cases.

5.1.3. Conducting soil gas and indoor air sampling or sub-slab and indoor air sampling simultaneously is recommended.

5.2. Existing Building with a Basement. If a building with a basement is present on the site, the following sample progression shall generally apply: near-source soil gas, soil gas (3 to 5’ below the basement slab AND along sidewalls within 10’ horizontally of the building and >5’ deep), sub-slab, indoor air. Subsections 5.1.1 to 5.1.3 above also pertain to the basement scenario.

5.3. No Existing Buildings. For undeveloped sites or those with existing buildings and open space affected by VOC contamination where buildings could be constructed in the future, subslab and indoor air sampling are not available alternatives. In most cases, near-source soil gas samples should be collected. If reliable plans are available that demonstrate specifically where and the type of building that will be constructed on the site, targeted sampling can be conducted in that area. Near-source (deep) or shallow soil gas sampling may be appropriate, or both depending on whether the building will have a basement and, if so, the depth of the basement). Appropriate sampling should be conducted directly in and around the footprint of the planned building.

6. General Sampling Information

6.1. Soil gas sample locations and the number of sampling points shall be sufficient to ensure the data is representative of soil gas within the full extent of the soil contamination. When used to evaluate an existing building, sub-slab sampling locations and the number of sampling points
shall be sufficient to ensure the data is adequate to allow an assessment of the vapor intrusion risk associated with a specific existing building.

6.2. [Placeholder for Sampling Frequency and Duration Requirements]

6.3. Mitigation. If vapor intrusion is determined to pose an unacceptable risk, it may be addressed through remediation (e.g. contaminant removal), mitigation (e.g. vapor mitigation systems), and/or Activity and Use Limitations (e.g. environmental covenants) to reduce risk to an acceptable level. More than one of these approaches may be used simultaneously at a site.

6.3.1. Remediation. Includes contaminant removal and in-situ destruction by methods such as excavation, vapor extraction, and in situ biological or chemical remediation.

6.3.1.1. Excavation. The elimination of RBTLs for subsurface soil for VOCs is problematic with regard to verification sampling when remediation occurs via excavation. Excavation is still a major remediation technique for many sites. In most cases it is not practical to evaluate an excavation using vapor sampling, for several reasons: 1) Vapor sampling near the excavation walls may not be representative of equilibrium (or at least stable/quasi-equilibrium) conditions due to the disturbance of soil and exposure of the excavation wall to ambient air; 2) vapor sampling is more involved than soil grab sampling, requiring vapor wells which take time and expense to install, must be sampled more than once, and may be destroyed if further excavation is done; 3) the turnaround time for a soil vapor assessment is not compatible with the typical time frames of excavation and backfill; and 4) it is not feasible to excavate, backfill, construct new buildings, wait an unknown length of time for the system to reach equilibrium, and only then determine through sub-slab or indoor air sampling whether the remediation was effective. Vapor Intrusion guidance documents (including EPA and ITRC) have not proposed workable solutions to this specific problem. Therefore, it is appropriate to establish soil concentrations, or a process for determining site specific soil concentrations, specifically for excavation verification. Options include:

6.3.1.1.1. Excavate to non-detect levels in soil
6.3.1.1.2. Excavate to levels in Table (___) which are based on JEM. These target levels are not to be used in risk assessment for VI, but only for excavation verification. Note, however, that meeting the levels in Table (___) may not alleviate the vapor intrusion risk to future buildings from the remaining
contamination. Further vapor intrusion investigation and risk assessment will be necessary prior to constructing a building in the excavation area in the future.

6.3.1.3. Excavate to some other concentration determined site-specifically. For example, the remediation may also be addressing other risks such as leaching to groundwater or removal of saturated soil (free phase contamination). Other targets can be used in these cases, particularly if a vapor mitigation system is to be added to a new or existing building. If sufficient data was collected during the soil delineation process (described earlier), it may in some cases provide enough information to estimate a soil concentration below which near-source soil vapor is below applicable RBTLs.

6.3.2. Mitigation – Installation of vapor intrusion mitigation systems on existing or new buildings to reduce exposure to acceptable levels. In addition to standard requirements of a RAP, performance-based requirements for mitigation systems and required information to be included in a VI mitigation system RAP can be found at (___). In view of the rapidly changing array of mitigation technologies, this guidance does not specify products, materials or methods, or applications. New and improved technologies are expected to appear. To be approved, a mitigation system must be reasonably expected to perform adequately for the COCs and conditions.

6.3.3. Activity and Use Limitations. Restrictions on land use, O&M plans for mitigation systems, requirements for mitigation systems for future buildings on all or part of the site, or requirements for future sampling/risk assessment of site conditions at the time a future building is designed.

6.3.3.1. If a mitigation system is installed as part of a RMP, an environmental covenant will typically be required to ensure the system is maintained in the future. O&M plans are recommended as a stand-alone document which will typically be an attachment to the covenant. Required elements for an O&M plan can be found at (____).

6.3.3.2. Future Buildings - If the site or certain areas of the site are found to be unsafe for construction of enclosed buildings due to potential vapor intrusion risk at the present time, construction can be prohibited, or subjected to additional requirements to ensure safety, through an environmental covenant. The goal of
these restrictions is not to prohibit reuse but to facilitate it by specifying actions to be taken to ensure safety. Because COCs may migrate or naturally attenuate, vapor intrusion risk is best evaluated based on the location and design of a proposed building at the time a building is proposed. The environmental covenant would therefore specify that construction is allowed with prior written approval from the Department after further evaluation. The approval process may require, but not necessarily be limited to, the following activities:

- Sampling to evaluate current site conditions in the proposed building footprint;
- Risk assessment based on the proposed building design, location, and use; COC concentrations; and standards in place at the time of the evaluation; and
- Approval of a remediation plan and/or mitigation system design, if required based on the aforementioned evaluation.

6.3.4. A covenant may also simply specify that a suitable mitigation system be installed in any building constructed in a specified area of the site (or the entire site). One or more of the above measures simultaneously may be appropriate for the site.

7. Developing Tier 2 SSTLs for VOCs. Because the equations and equation input factors used to update the RBTLs for all chemicals of concern (COCs, including VOCs) are different from those used to develop the RBTLs in the 2006 MRBCA guidance, the process and the data used to develop Tier 2 SSTLs has also changed.

7.1. At Tier 2, remediating party may use site-specific fate and transport parameter values instead of the default values.

7.1.1. The default values for exposure parameters and COC physical/chemical properties and toxicity parameters may not be changed at Tier 2.


7.2.1. For VI-related SSTLs, use the EPA Vapor Intrusion Screening Level (VISL) Calculator available at [http://www.epa.gov/vaporintrusion](http://www.epa.gov/vaporintrusion). When using VISL, be certain to adjust the carcinogenic risk level to the Missouri risk level of 1x10E-05 (or 1 in 100,000 Increased Excess Lifetime Cancer Risk).

7.2.2. Other models. Must be approved by department. Needed to develop AFs.

8. Tier 3. The Tier 3 process for VOCs is the same as for non-volatile COCs.
9. Representative Concentrations for VOCs.

9.1. Near-Source Soil Gas. [expand]

9.2. Soil Gas. [expand]

9.3. Sub-Slab Soil Gas. [expand]

9.4. Indoor air. Indoor air samples must be evaluated on a sample-specific basis. Development of a representative or average indoor air concentration is not allowed, except to the extent averaging is inherent to sample collection, e.g., 24-hour or 12-hour sample. The indoor air sampling plan shall specify the volume of the building that each sample is intended to represent. To evaluate indoor air data, compare the concentration of each COC detected in a sample to the indoor air RBTL for each COC.